32nd URSI GASS, Montreal, 19–26 August 2017

On Measuring Elevation Angle of Returns with SuperDARN HF Radars

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1 Extended Abstract

Super Dual Auroral Radar Network (SuperDARN) HF radars scatter signals from E- and F-layer decameter-scale, field-aligned irregularities in plasma density using electronically steered phased-array antennas. The antenna array designs of these radars creates an antenna pattern with a narrow beamwidth in azimuth but a relatively broad (≈35°) beamwidth in elevation [1]. This broad elevation pattern is desireable for transmitting and receiving signals over a variety of possible over-the-horizon (OTH) propagation paths that depend on the density of the ionosphere and the frequency of the signal. In order to determine the elevation angle of received signals, the SuperDARN radars use a second, and sometimes a third [2], receive-only antenna array offset from the primary antenna array. Measuring the time difference of signal reception on the arrays leads to a calculation of the elevation angle since the speed of propagation, azimuth angle and distance between the antenna arrays are known. While the time difference that is needed for this calculation occurs at the antenna arrays, the time difference that is measured includes time delays through coaxial cable and receive electronics. Differences in the time delays along these receive paths introduces errors to the calculation of angle of arrival of the signal. While the coaxial cable time delay measurement is straightforward, measuring the time delay through the electronics can be complex especially as there are differing designs of these electronics across SuperDARN radars. Here, the various issues and techniques of measuring time delays with a few representative SuperDARN radars will be discussed as well as results from elevation angle measurements at the Blackstone SuperDARN radar. We will compare modelled elevation angle data with the results of measurements over radar fields-of-view.

References

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[2] E. Custovic, A. J. McDonald, J. Whittington, D. Elton, T. A. Kane, and J. C. Devlin, “New Antenna Layout for a SuperDARN HF Radar," *Radio Science*, textbf48, pp. 722-728, doi: 10.1002/2013RS005156.